Relationship of Slash to Beetle Infestations in the Various Ponderosa Pine Regions

by

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To the Faculty
School of Forestry
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Gentlemen:

I hereby submit this thesis in partial requirement for the Degree of Bachelor of Science in Forestry.

It is the wish of the writer to express his sincere appreciation to Mr. F. P. Keene of the Entomological Branch, United States Department of Agriculture, Pacific Northwest Experiment Station, Portland, Oregon and to Professor Dan Bonnell, Department of Entomology, School of Agriculture, Oregon State College and others in the United States Forest Service, who so generously utilized their time and effort to help compile the material that furnished the basis from which this thesis was written.

Very truly yours,

[redacted]

Charles S. Lewis

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FOREWARD

Slash as a Factor in Forest Protection

Does slash from cutting operations increase the insect menace in living trees? Many times this question has been asked by foresters and timbermen, but there has been little uniformity in the answers. Considerable confusion has arisen as a result, and a great diversity of opinion is found concerning the influence of slash upon insect outbreaks.

Therefore the purpose of this paper is to try and bring forth a logical answer to this question.

PART I

PAST EXPERIMENTS IN THIS FIELD IN U.S. AND CANADA

Two widely divergent views are held by professional forest entomologists in North America. In Canada, Swaine and Hopping advocate on entomological grounds the necessity of slash disposal as a phase of forest protection. On the other hand, workers in the United States, Graham, for example, almost unanimously take the opposite viewpoint that under the present economic conditions slash disposal cannot be justified on entomological grounds. (2)

Chamberlin, however, recommends the burning of the slash of Ponderosa Pine for the control of bark beetles. In England, Munro, Entomologist of the Forestry Commission, also recommends this burning procedure. It is fully realized, however, that a broad statement of applying indiscriminately to all forested regions is out of the question; the problem varies with each forest region and the type and within each region. (2)

Hopkins in 1899 called the fact to the attention of the wasteful methods of lumbering in the Pacific Northwest and the attractive breeding places for the forest insects, in the scarred trunks and debris left on the ground. Ten years later, in one of his papers he suggests that the cutting of live timber for commercial purposes may offer favorable conditions for the multiplication of some of the bettle species, although in some cases it may serve as a protection to living timber, and suggests burning the slash after it has attracted the beetles away from the living trees.

There are hundreds of species of insects that breed in the slash of forest trees, but few of these are capable of doing much injury to living trees. They attack the base, trunk, tops, limbs or twigs of mature standing trees; others emerge from the slash and attack seedlings, saplings and poles.

In addition to this, slash has a very strong attractive influence which may result in bringing thousands of insects into the general slash area with a resultant varying damage to living timber.

The direct result of insect attack upon the slash itself is beneficial because the insects aid in bringing about decomposition. In this paper the direct influence of insects upon twigs, limbs, and tops can be ignored and only the role of slash need be considered in (1) supplying breeding material for insects which emerge and kill mature standing timber or seedlings, saplings, and poles, and (2) attracting insects from the surrounding forest and concentrating them in the vicinity of the slash, where they kill young living trees.

In general, the insects with which this paper is concerned breed in the same parts of a fallen tree as in the standing tree. Insects which attack the base of a tree are found breeding in the stumps on slash areas, those attacking limbs and twigs breed in limbs breed in those corresponding portions of the slash. There are, however, some important exceptions to this rule, such as certain species of Ips.

Probably the heaviest losses of all are attributable to the effect of slash in attracting beetles from the surrounding territory and concentrating them in the vicinity, where they are able to do ~~the~~ greater damage to the standing timber than if their attacks had been scattered over a wider area.

This attractive influence has been noted many times in studies carried on in various slash areas over the forested regions of North America. The felling of trap trees has often concentrated attacks on adjacent healthy trees, even in some cases in which the felled trap tree has not been attack. The beetle population is usually attracted to fire scorched areas, even though the beetles are often unable to breed successfully in the trees weakened by fire. It is also usually attracted to places where heavy windfalls have occurred or trees broken by snow.

It is evident that this damage so classified cannot be minimized through slash disposal. In fact, burning the slash in the summer, which is the flight period of these beetles, may even increase the attractive influence and bring about a still greater proportion of beetle concentration. (2)

This aforementioned work will be expounded upon in greater detail as the various Ponderosa pine regions are dealt with.

PART II

FOREST REGIONS IN THE PONDEROSA PINE BELT

First let us digress a bit from the Ponderosa Pine Belt and see what results were obtained in the Southern Pine region.

Dr. A. D. Hopkins made a study on the attractive influence of slash and he contends that if a pine tree standing in or near a grove of pine woods, is eather struck by lightning or felled, barked or split into cordwood during the summer or early fall, it will (as a rule) attract the beetles within a radius of 3 or 4 miles and be responsible in starting a new infestation and the death of a large number of trees. He further states that it is dangerous to cut pine during the summer months when the Southern Pine Beetle (Dendroctonus frontalis Zimm.) is working. (7)

Jumping from the Southern Pine Region up into the Lake States Region, Itasca State Park Minnesota to be specific, there Dr. S. A. Graham ran a somewhat similar and interesting experiment.

His experiments were carried on in slash areas of Pinus resinosa, Pinus divaricata, and Pinus strobus. The areas ran from varying degrees of light intensity to full sunlight and on burned and unburned slash. (4)

His findings were as follows:

1. Very few truly primary insects were found breeding in the slash.

2. Normally harmless species occassionally were

found occurring in such great numbers that they did become temporarily injurious. Although they breed in slash, the larger pieces of the debris seemed more suitable to their need than did material under 6" in diameter.

3. Stumps furnish ideal breeding places for insects.

4. Pieces lying near the ground in the bottom of the slash piles were entirely unsuitable as food for injurious insects, but serve only as a breeding place for purely harmless and beneficial species of insects.

5. In practically no slash burning operation is any effort made to char the stumps, and ordinarily only the larger pieces are used to weight down the slash piles. This practice proved to be very ineffective as a means of insect control. (4)

Dr. Graham recommended that in order to accomplish a satisfactory control and destruction of beetle broods, all of the large branches, tops, broken logs, and butts, should be thoroughly scorched by fire and the fires should be built over the stumps. (5)

Therefore burning cannot be effective under its existing application, as an insect control. A more effective and suitable method of insect control is to pile the slash over stumps, with the heavier material laid next to the ground and the finer pieces on top, thus preventing the multiplication of harmful insects. (4)

The results of Dr. Hopkins and Dr. Graham are not directly applicable to the West's Ponderosa pine belt but they do offer a valuable background for the study of it.

SOUTH WEST PONDEROSA PINE REGION

In this region the Ips beetle is attracted in great numbers to areas of freshly cut slash. When such a concentration occurs the beetles tend, upon emergence, to hit young trees in the sapling and pole stages. If logging operations are suspended in localities subject to Ips beetle attacks, then all slash should be burned and the bark should be peeled from the large material left in the woods after logging, thus destroying suitable breeding places for these insects. (2)

BLACK HILLS PONDEROSA PINE REGION

The Black Hills beetle, (Dendroctonus ponderosae Hopk.) although potentially ~~it can~~ able to quickly develop into epidemic stages, logs, in recent years constantly available through continual logging have apparently absorbed enough of the beetles while in flight to prevent an increase in the insect population to the epidemic stage.

Ips rarely does any damage as long as there is a continual supply of green slash to absorb them.

These points are illustrative of the factor which utilizes slash as a trap and thus by destroying the slash in burning or piling methods the beetles likewise are destroyed in the larval and pupal stage. (5)

CALIFORNIA PONDEROSA PINE REGION

The first study was carried out on a highway right of way transgressing through Southern Oregon and Northern California. The experiment was on an area of slash consisting of whole trees over a 24 mile length. Slash was cut in every month except July, August, and September. The timber, of course, was Ponderosa pine and the species of beetles ~~were~~ was the Western pine beetle (Dendroctonus brevicomis, Lec.), the only one found in sufficient quantities to warrant study. Others found in the infestation were the Mountain pine beetle (Dendroctonus monticolae, Hopk.), the emarginate ips (Ips emarginatus, Lec.), California five-spined engraver (Ips confusus, Lec.). Only the exit holes of the Mountain pine beetle (D. monticolae, Hopk.) were counted. (13)

Slash was attack during May, and June, in fact 97.5% of the down timber was attack indicates fresh slash has a very strong attraction for insects.

Period of emergency July and August; trees were examined and counted in September.

A study of the infestation by bark beetles in standing mature timber of the Ponderosa pine region at the same time showed that on an average, under normal conditions, there were 23 attacks and 54 emergences per square foot, numbering 235%, and the resulting numerical increase of 135% of the attacking insects. (13)

In the felled trees of slash there were found to be an average of 11 attacks and 18 emergences per square foot, emergences numbering 164%, an increase of 64% over the attacks.

These data afford evidence of the high mortality which attends the breeding of bark beetles in slash, as contrasted with normal broods developing in standing trees. As the conditions of slashed trees are approximately the same where ever they are found in this particular locality, the data obtained on slash in other areas in this same locality will not be very different.

When the board feet were computed for the entire 1,075 slashed trees there was 1,557,690 board feet in all: of these, 1,048 trees, or 97.5% of the total content had been attack by bark beetles. Of the 1,048 trees attack, 901, or 86%, containing 1,401,920 board feet or 92.4% of the total content were found to have been the breeding places of beetle broods which had emerged. The significance of this high percentage is not, however, so great as might be at first supposed, for most of these broods suffered an abnormally high mortality in the larval and pupal stages, with the results that the new adults that emerged were in many cases fewer in number than the adults which entered the slash. This abnormal mortality was caused chiefly by changes in the moisture content of those portions of the tree which constitute the food supply of the developing beetle. (13)

Green slash attracts to it only about one-half the number of beetles per unit bulk as do standing trees. The Western pine beetle (D. brevicomis, Lec.) and other beetles breeding in green slash do not greatly influence infestations in the surrounding forests. The cycle of infestation continues regardless of the slash factor. (15)

This study indicates that the infestation of the slash by Dendroctonus brevicomis is not a serious menace to the neighboring mature timber, and may be disregarded when the problem of slash disposal is under consideration.

In this same area another experiment in mill and road slash studies were carried on.

The slash examined was r epresentative of the typical logging debris left in the woods in the Klamath Basin. It included butts, cull logs, tops, and branches cut between June 1, 1922 and June 1, 1923. (15)

The examination was carried out thus:

Sample pieces of slash were selected and numbered. These samples were all over 12" in diameter because from a previous experiment that no primary insects breed in appreciable numbers in material of smaller diameters. (?) (15)

The size and numbers and the species of insect found in each piece was noted. In the right-of-way slash studies the pieces consisted of logs or whole down trees.

The per cent of the mill slash pieces infested ranged from 5-95% with an average of 32.8% or less than half. The number of infested logs in the right-of-way studies ranged from 34-89% with an average of 59%. (15)

Using Keene's Normal Infestation Tables based on studies made around Ashland, Oregon in 1915 and 1916, we find that the highest number of attacking Dendroctonus brevicomis for all areas was only 66% of normal. (10)

Figure 1
Ashland Infestation Studies (Keene's)

Attach per sq. ft.	6.80
Beetles per attack	2.60
Attacking beetles/sq. ft.	17.60
Emergence per sq. ft.	80.00

The emergence for the mill and road slash areas, 11 in all, ranged from 9-23%, respectively, of the normal. (15)

In ten areas the infestation in the timber surrounding the slash was found to have decreased following the cutting. In only one area was there an appreciable increase in the surrounding infestation. In two areas the infestation was static. (15)

Factors Influencing Results

1. The infestation was on the decline over the entire area.

2. The natural enemies of the bark beetles had increased to a point, where aided by control operations, they actually reduced infestations.

Beetle Mortality on One Acre, given according to the Exposure of Slash

Diameter inches	Exposed Foot Length							Beetles per Square foot
	2	4	6	8	10	12	14	
2	91.7	128.3	50.0	6.1	2.5	0.18	0.0	545
4	40.5	49.0	34.2	10.1	2.8	1.0	0.2	535
6	4.4	11.1	6.4	4.6	1.5	0.5	0.4	239
8	1.2	3.2	3.1	2.6	1.6	1.0	1.6	184
10	.7	1.7	1.2	2.3	1.8	1.2	.8	238
12	.4	1.4	1.3	1.5	1.6	.8	.4	165
14	.3	.6	.7	1.6	.1	.5	.1	90
16		.2	.1	.4	.2	.1		38
18	.09	.09	.3	.1	.09			19
20		.3	.1	.1	.09			18
22				.09				3
24		.4	.09	.09	.09	.09		30
24 plus		.1					.09	13
							Total	2117
				Shaded				
2	20.3	39.1	15.9	4.0	.3	.09		172
4	9.4	18.7	14.6	4.0	1.1	.4		240
6	.6	3.9	2.1	2.4	1.1	.5		98
8	.2	1.0	1.8	1.6	1.1	.8	.5	130
10		.4	1.2	1.5	1.6	1.4	.5	159
12	.09	.3	1.6	1.7	1.0	1.0	.7	133
14			.1	.1	.1	.3	.3	38
16		.1	.09			.09		8
18	.09		.09				.09	9
							Total	987 (1)

Figure 2

3. Only one area out of 11 studied, was cut at a time, favorable for infestations.

4. The major emergence had taken place in June and July before the slash was present on the ground thereby taking in only the second and somewhat smaller minor emergence.

It was noted where slash was cut in early spring there was no apparent increase in the surrounding timber, but no decrease was indicated either. (15)

It has been the experience of some entomologists in the United States and Camda, the increase from the initial infestation, supposedly caused by slash is not apparent for several years. Fresh slash may take up much of the emergence. (15)

NORTH WEST PONDEROSA PINE REGION

A series of experiments were conducted by J. A. Beal on logging slash debris in the Ponderosa pine belt from Klamath Falls, Oregon to Curlew, Washington. The results were as follows.

A 3-year study on insects in Ponderosa pine logging slash on representative areas from Southern Oregon to Northern Washington has been made. This phase of the study covered insect breeding in cull logs, butts, tops, and smaller slash disposal were encountered in the study. A measurement of conditions favoring for insect increase and determination of unfavorable conditions for rapid decrease was attempted.

High Subcortical Temperature, of exposed slash were found to be important in keeping down the number of slash insects throughout the region studied. The degree of heating was found to depend chiefly upon the solar altitude, the sun's

Western Pine Beetle Attacks and Emergence per square Foot on Five Slash Logs and Four Standing Trees

Log	Exposure	Top		East		West		Butt	
		Att.	Emer.	Att.	Emer.	A.	E.	Att.	Emer.
1	Exposed log on ground Few limbs	1.8	0.0	7.4	0.0	15.6	2.0	33.8	1.2
2	Exposed log off ground Few limbs	6.2	0.3	12.4	24.4	8.6	5.0	72.4	16.7
3	Exposed log on ground Limbless	1.0	1.0	23.0	24.3	4.0	4.6	16.8	24.6
4	Shaded log off ground Few limbs	15.0	35.4	26.0	74.8	26.2	61.4	18.4	60.0
5	Part shaded off ground 1-3' limbs	3.8	0.0	9.4	34.0	9.6	53.6	14.4	160.8

Figure 3a (1)

Standing Tree	Attack	Emergence
1	12.0	122.1
2	28.8	85.9
3	17.8	180.2
4	21.2	95.2

Figure 3b (1)

intensity, the angle of exposure, bark thickness and temperature and air movement.

Light Intensity is extremely important in its effect on subcortical temperature, however, this factor is subject to large and rapid changes and a measure of duration as well as intensity is necessary before its full significance can be appreciated.

Solar Altitude varies considerably from season to season but during midsummer where was only 7 degrees difference in the noon angle of the sun at the 2 most extremes points in the region so no very great difference in the effect of the sun on the slash could be anticipated. The angle of incidence has a most important being on subcortical temperatures, slash perpendicular to sun's rays absorbs the maximum amount of heat, as the angle of incidence increases more light is reflected and less absorbed. In Ponderosa pine bark ½" thick this difference at noon is 3 degrees Farenheit for each 10 degrees change in the angle. The effect of this factor is further illustrated in slash on north slopes where fatal high temperature are less often found.

Bark Thickness is an important factor. The thicker the bark, the greater the protection offered by it. The subcortical temperature of exposed slash is directly proportional to the bark thickness.

Air Temperature effect is entirely overshadowed by the effect of light, and air movement together with air temperature markedly affects subcortical temperature of slash.

Slash Record of the Oregon pine engraver
(Ips oregoni, Eichh.) by Pieces Attack

Class	Piece	Top	North	South	Butt Log
			Sun East and West		
1	64	0	0	0	5
2	55	0	3	0	11
3	24	0	3	1	7
4	39	1	11	5	18
5	19	0	3	1	10
			Shaded		
1	40	31	33	33	32
2	23	21	20	20	21
3	16	12	13	13	12
4	7	6	6	6	6
5	2	2	2	2	2

Figures given here are for Southern Oregon

Figure 4 (1)

Moisture was found to be much less a factor in limiting insect development in slash than was temperature. Excessive moisture appears to have caused reduction in broods of the Western pine Beetles (D. brevicomis, Lec.), but had no appreciable effect on the Oregon pine engraver (Ips oregoni, Eichh.). Insufficient moisture may have been a factor in some of the exposed slash of smaller sizes, however, it was overshadowed by the effect of high temperature. (1)

The Dendroctonus brevicomis was not attracted to slash of smaller sizes (under 6" diameter) and ordinarily did not find suitable breeding conditions in the larger sizes to which it was attracted. In only rare cases was it found producing good broods under slash conditions. The inability of this insect to increase rapidly in slash and felled logs should eliminate it from serious consideration as a menace in Ponderosa pine slash areas.

Other insects of economic importance, but found only in small numbers in the Ponderosa pine slash were the Mountain pine beetle (D. monticolae, Hopk.), the red turpentine beetle (D. valens, Lec.), the Large Oregon pine engraver(Ips emarginatus, Lec.) and species of Buprestids and Cerambycids. (1)

The Oregon pine engraver beetle (Ips Oregoni, Eichh.) was attracted to practically all sizes of slash and logs and increased very rapidly under protected conditions. It favored shaded material such as limby tops and brush piles, and reproduction itself under these conditions six times as abun-

Forest Insects Emerging From Ponderosa pine
Slash according to Size, Exposure, and Region

*Part I

Class	Size (dia)	Sun	Shade	Dendroctonus brevicomis Sun	Dendroctonus brevicomis Shade	D. valens S.	D. valens Sh.	D. montic. S.	D. montic. Sh.	Ips emarg. S.	Ips emarg. Sh.
1	Limbs 1-3"	1,380	6,625	0	0	0	0	0	0	0	0
2	Limbs 4-8"	1,743	7,689	0	0	0	0	0	0	0	3
3	Tops 1-6"	1,282	13,611	0	0	0	0	0	0	1	0
4	Tops 6-12"	2,403	11,538	0	349	0	0	0	0	0	0
5	Logs 12"	865	7,494	102	541	119	1	0	95	0	3
Total		7,673	47,412	102	896	119	1	0	95	1	3

Figure 5a

*Part II
All Class Four's, (Tops 6-12" Dia.)

North Lats.	Region State	Sun	Shade	Dendroctonus brevicomis Sun	Dendroctonus brevicomis Shade	D. valens S.	D. valens Sh.	D. montic. S.	D. montic. Sh.	Ips emarg. S.	Ips emarg. Sh.
42°	Klamath Falls	893	7,464	195	2	0	0	0	0	0	0
44°	Bend Oregon	857	4,722	6	14	0	2	0	0	0	0
46°	Baker Oregon	524	3,351	0	0	2	0	0	0	152	0
46°	Gold-dale, Wn.	1,158	7,652	--	4	0	0	28	1	0	0
48°	Curlew Wash.	1,236	4,560	56	0	0	0	0	0	0	0
Total		4,768	27,749	251	20	2	2	28	1	152	0

Figure 5b

*Part I refers to insect emergence from 272 sq. ft. of shaded and 272 sq. ft. of exposed slash classes (5) in Southern Oregon.
*Part II refers to 150 sq. ft. of shaded and 150 sq. ft. exposed material in Oregon and Washington.

dantly as in material exposed to the sun. Slash scattered in the sun produced very light broods of this insect and in many cases no brood at all. (1)

An analysis of slash conditions on an acre basis on one area showed that 2/3 of the slash resulting from tractor logging could be classified as unsuitable for insect increase, while 1/3 was either shaded by its own limbs or was felled into reproduction, which protected it and thus formed good breeding material for Ips oregoni. (1)

Reproduction studies indicated that generally speaking the insect losses on an average area of continued logging were small. This damage is usually sporadic and more often follows the interruption of logging operations in the summer months. Ordinarily losses are associated with poor sites or other adverse growing conditions. (1)

The results of the study indicates that the damage caused as a result of insects breeding up in the slash may be more closely related to the condition of the trees attack than to the number of insects produced in the slash.

The results of the examination of windthrown Ponderosa pine in Southern Oregon indicate that insect increases in this material had been about ½ that found in standing trees. This increase has not been great enough to result in epidemic conditions on the area. (12)

BRITISH COLUMBIA, CANADA PONDEROSA PINE REGION

In Canada, experiments by Ralph Hopping were carried on in beetle outbreaks occurring near the edges of fresh cuttings at Kingvale, Voght Valley, Lorna, Midday Valley, and Coldwater, B. C., 1923. (8)

At this time the infestation was gaining impetus not only in B. C., but in the Ponderosa pine belt of California, Oregon and Washington as we just have surveyed.

The timing and similarity of the outbreaks in these regions were so consistent that they seemed to indicate a direct relationship to one another. As general as these observations were, they are substantiated by experimentation that previously has been brought forth.

The experiments carried on in B. C. were to ascertain by use of caged material, the number of primary insects emerging from various types of Ponderosa pine slash. The first of these experiments were conducted during the winter of 1923 and the spring of 1924. (8)

During the fore part of June, 1924, before the first Dendroctonus emergence had begun, five representative slash areas were selected and caged. The slash was caged exactly as it was found and only the wood itself was left inside thec age, and it included two cages with a cull log each, two with tops each, and one contained a stump.

The contents of each cage was collected daily during the period of emergency and for a sufficient time thereafter to be sure the emergence had ceased.

The collection started about June 20 and continued until about August 20, approximately a period of 60 days. (8)

The following table shows the number of Dendroctonus beetles by species, and Ips species are grouped together, which emerged from the caged samples.

B eetles species	Cull log	Stump	Top
D. brevicomis	61	3	2
D. monticolae	6	4	72
D. valens	1	0	0
Ips	43	272	71

Figure 6
Beetles by species from caged plots (8)

It is noted that in the cull logs, D. brevicomis outnumbered D. monticolae, while in the tops the reverse is true. In stumps, Dendroctonus species are few, while Ips are far more numerous than in other samples. Since Ips emerge earlier than does Dendroctonus, it is believed that some may have emerged previous to the construction and establishment of the cages. (8)

On this logging area, sample areas averaged 15 stumps, 15 tops and 3 cull logs. This brings the average per acre to 1434 Dendroctonus and 5232 Ips.

These trivial numbers became rather significant when they are multiplied by the total number of acres of fresh slash. With 100 acres of slash, and this is not uncommon, means that 143,400 Dendroctonus and 523,000 Ips are emerging.

It is probably that this number of primary and secondary beetles, concentrated as they are may be sufficient to attack and kill a small group of living trees thus producing the focal point of an infestation. (8)

If, however, the infestations were on the decrease over the entire region, these beetles probably have little effect but where no infestation had as yet occurred, except in endemic proportions, or where the infestations were small and on the increase, it seems likely that the concentration indicated by these experiments would contribute an added impetus to the infestation, or as in the first case, cause the start of one. From all factors considered, it appears that green Ponderosa pine slash does concentrate Dendroctonus and other destructive bark beetles in numbers great enough to cause danger to adjacent stands.

Another experiment in B. C. was carried on with entire down trees caged and the beetles emerging were counted in the same manner as was this previous Canadian experiment. The diameter of the tree, beetle by species and total number of beetles were recorded for each log as is noted in the following table.

Diameter	D. brevicomis	Ips	D. monticolae	Total
18"	62	996	4121	4183
24"	1694	1651	4699	6393
36"	4547	1673	2423	6970

Figure 7 (9)

It appears that the smaller the size of material, the greater was the proportion of D. monticolae, the larger the size, then D. brevicomis, was in the majority with 4-7 thousand adults from mature trees. (9)

An experiment was conducted on a 32" Ponderosa pine that was felled and caged and the results were found as indicated in the following table.

Beetle species	Stump	Trunk	12" Top	Limbs	Total
D. brevicomis	567	3977	1	2	4547
D. monticolae	10	836	1497	80	2423
Ips	0	33	22	1619	1673
Pityogenes	2	42	80	12,288	12,412

Figure 8

Beetle Count on a Felled and Caged 32" Ponderosa Pine (9)

Notice all but 3 of the D. brevicomis came from the stump trunk, or the top; that the limbs bred 82 beetles of the genus Dendroctonus, the top 1497 and the stump 577. (9)

The top, limbs, and stump are all left on the ground in logging operations and we know they are heavily attack by Ips, Dendroctonus, and other bark beetles, although not always in the proportions given in the above table. It is nevertheless more than an indication of the danger of leaving unburned slash and stumps upon a logged over area without destroying or making it unfavorable for insect breeding at the proper time. (9)

There is an enormous number of secondary beetles which occassionally become primary in importance for a short time only. They breed in limbs, tops and stumps. These beetles can't be ignored, however, since they are what may be termed subprimary, attacking in large numbers and probably enabling the Dendroctonus to overcome the trees resistance more readily. (9).

PART III

METHODS OF TREATING AND DISPOSING OF SLASH TO ELIMINATE INSECT MENACE

Slash has been considered in this thesis as a major influence in some cases and a minor influence in other cases where beetle breeding conditions and infestations are concerned. Provided that slash is a major source of insect development then steps should be taken by all means to remove it from the woods.

Recommendations from several of the authors of experiments dealt with have brought out that windfalls should be eliminated as much as possible when timber felling is being done. This factor would considerably lessen the subsequent danger from beetle breeding grounds if this practice were to be followed. Stumps of felled trees should be carefully earthed over, especially in the coniferous forests of North America, because they offer prime conditions for egg desposition by harmful forest insects such as Dendroctonus and Ips. (12)

Timber should be felled and logged during that season, namely June, July, and August, at which time the debris left, is not apt to form an incubator for Scolytidae. Immediate steps should be taken to remove, burn, or lop and scatter the slash thus creating unfavorable conditions for moisture and exposure which is an inimical factor for the perpetuation of beetle breeding. The debris can be used as a trap, and the insects can be destroyed to a great degree by burning or exposing the debris after the beetle flights have hit the slash. In this manner the beetles are destroyed in the pupal or larval stages. (3)

If, however, the logging debris cannot be removed from the woods before breeding season, then all the down timber over 12" diameter should be barked or burned. (16)

Another method of treating slash when it cannot be removed or burned is by exposure. The material should be lopped and scattered thus utilizing the direct rays of the sunlight to kill the beetle broods. This method of treatment has been very effective in the destroying of Dendroctonus monticolae in Lodgepole pine and is applicable in Ponderosa pine. (14)

Cull logs must be rolled out in the open and ~~lying~~ placed in a north and south direction, ~~thus receiving~~ in order to receive the full benefit of the sun's rays. The logs must be limbed and topped with the brush scattered as mentioned before. These logs are to be left in this position from 2-5 days and then turned 1/2 way over in order to expose the other side. On north slopes it may be necessary and desirable to place the logs east and west and turn them twice, 120 degrees each time. (14)

As compared with burning treatment, or the earthing over treatment (stumps only, pile the rest), the Solar heat method is by far the cheaper, unless the slash is thoroughly cleaned up, then the cost is the same or slightly higher than burning but is still less than the cost for the earthing over treatment. When the limbs only are burned in the solar heat method then it is on par with burning as far as costs go. (14)

The main advantages of the solar heat treatment are t hat no standing trees are scorched and no condition attractive to insects ~~are~~ is setup by the work, as is the case when logs are burned. Its principal disadvantage is that ordinarily more slash is left in the forest, unless it is later burned at an additional expense.

PART IV

SUMMARY

1. Fresh cut Ponderosa pine slash does offer an attractive influence to injurious forest insects such as, Dendroctonus, Ips, and many other genera.

2. Ips, is attracted to practically all sizes of slash and logs and will increase very rapidly under protection (shaded conditions). Under such conditions, it will reproduce itself six times as abundantly as in material exposed to the sun. Sometimes, more often than not, Ips will attack young trees in the pole and sapling stages.

3. Normally harmless insects occassionally occur in such great numbers that they become what is termed "sub-primary" or temporarily injurious. Material 6" or ~~smaller~~ less in diameter is entirely unsuited to their needs.

4. Green slash will have an emergence of only about one-half the number of beetles per unit bulk as do standing trees.

5. Dendroctonus brevicomis is not a serious menace to adjacent mature standing timber. It is not attracted to slash under 6" and ordinarily ~~did~~ does not find suitable breeding conditions in the larger sizes (cull logs and stumps) to which it ~~was~~ is attracted. In only rare cases ~~did~~ does it produce good broods under slash conditions.

The inability of this insect to increase rapidly in slash and felled logs should eliminate it from serious consideration as a menace in Ponderosa pine slash.

6. Generally speaking insect losses on an average area of continual logging are small. Ordinarily, losses are associated with poor site and other adverse growing conditions. It is the condition of the tree attack surrounding slash areas, rather than the number of insects bred in the slash itself that causes infestation to be started in the same area.

7. The Canadian experiments bore out a slightly different conclusion in that both Dendroctonus brevicomis and Dendroctonus monticolae were very aggressive upon emergence, in their attack upon standing timber. They were attracted to slash in appreciable numbers, the D. brevicomis breeding in the larger parts of the slash while the Dendroctonus monticolae bred in the smaller parts of the slash debris. The reason for this is the variation, in the case of Dendroctonus monticolae, is the conditions, which were present, under which, the experiments were conducted.

CONCLUSIONS

In the conclusions that can be drawn from this thesis it is the opinion of the writer that:

1. Slash is only a minor factor, in harboring insects that can adapt themselves to the unfavorable conditions existing there, breed, and then attack and kill living trees.
2. Slash does offer an attractive influence to harmful forest insects, but damage caused as a result of insects breeding up in slash is more closely related to the conditions of the trees attacked than to the number of insects produced in the slash.
3. The factor of slash can be entirely disregarded in beetle control work, because the cycle of insect infestation in indemic and epidemic proportions remains present irregardless of existing slash conditions.

RECOMMENDATIONS

There is only one recommendation that can be made and that is the practice of better methods of slash disposal. This may be accomplished not by the immediate destruction of the slash itself because that would only tend to attract more insects into the area, but by better methods of piling the slash.

The most successful way to reduce the number of beetles breeding in the slash is to eliminate their access to the material suited to their needs. Therefore if the larger material is placed next to the ground where moisture is more abundant and then the smaller material is placed on top then a step in the right direction has been taken to eliminate the material suited for the breeding of injurious forest insects. Recommendations other than this are neglible in the control of forest insects when slash is considered as a factor.

The English used in this thesis is atrocious.
9.H.S.

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